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EP 0703087 A2

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(54) Abstract Title

Control of under and over printing level volumes during inkjet printing of a black object of height greater than a print swath to hide swath boundary banding

(57) The arrangement provides a dynamic adjustment for black ink volume to print a black object whose height is greater than a swath height of an inkjet printer. The printer includes one or more printheads 22-28 which move relative to a medium while the printheads are printing on the medium. The printheads include a first set of nozzles for printing dots of a first ink (e.g. black ink), a second set of nozzles for printing dots of a second fluid (e.g. a fixer or dye-based ink). The process dynamically adjusts the volume of the black ink which is printed over the second fluid according to a printer characteristic (e.g. printhead temperature, operating frequency, etc.). The black ink volume is greater than the volume of the second fluid. The volume of black ink is increased by using a greater number of nozzles in the first set compared to the number of nozzles used in the second set. The arrangement minimises white space swath boundary banding at underprinted black ink.

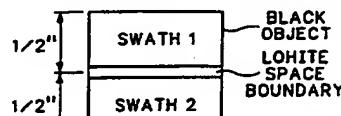


FIG.1A

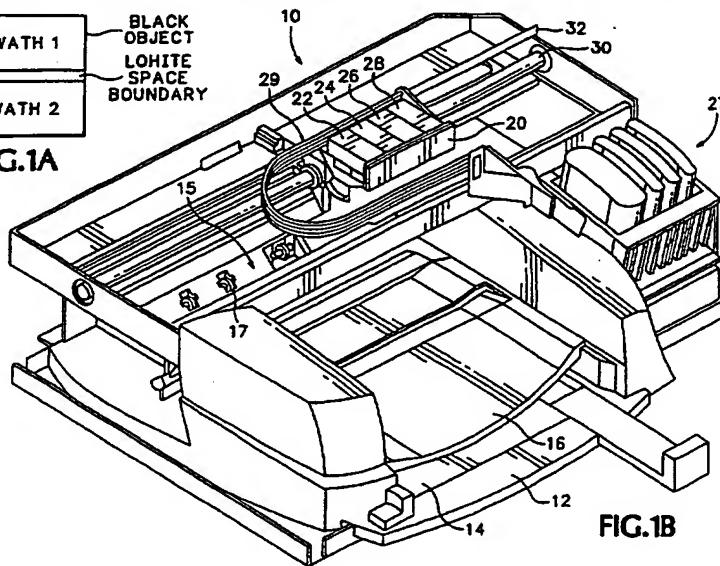


FIG.1B

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FIG. 1B

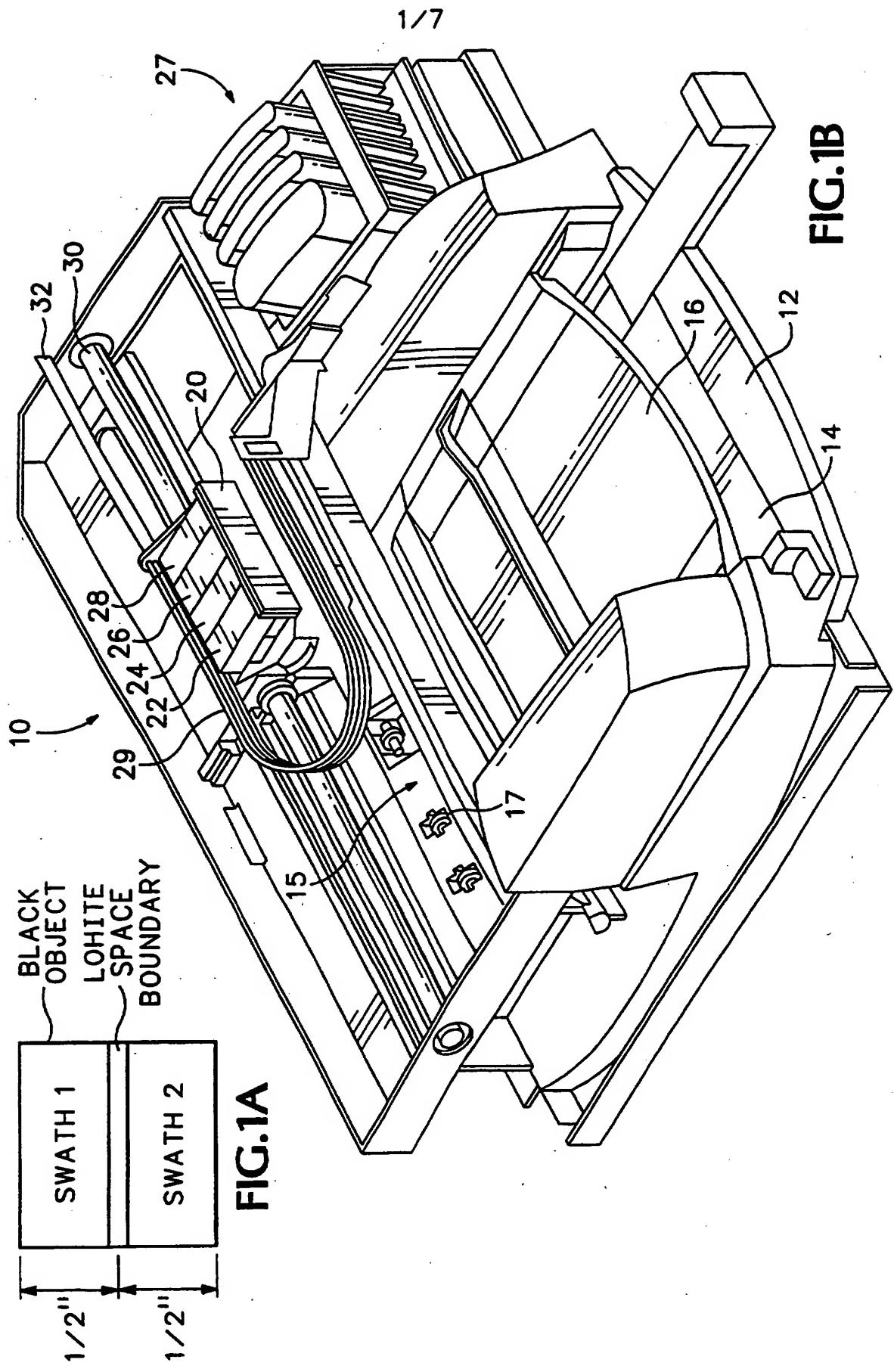
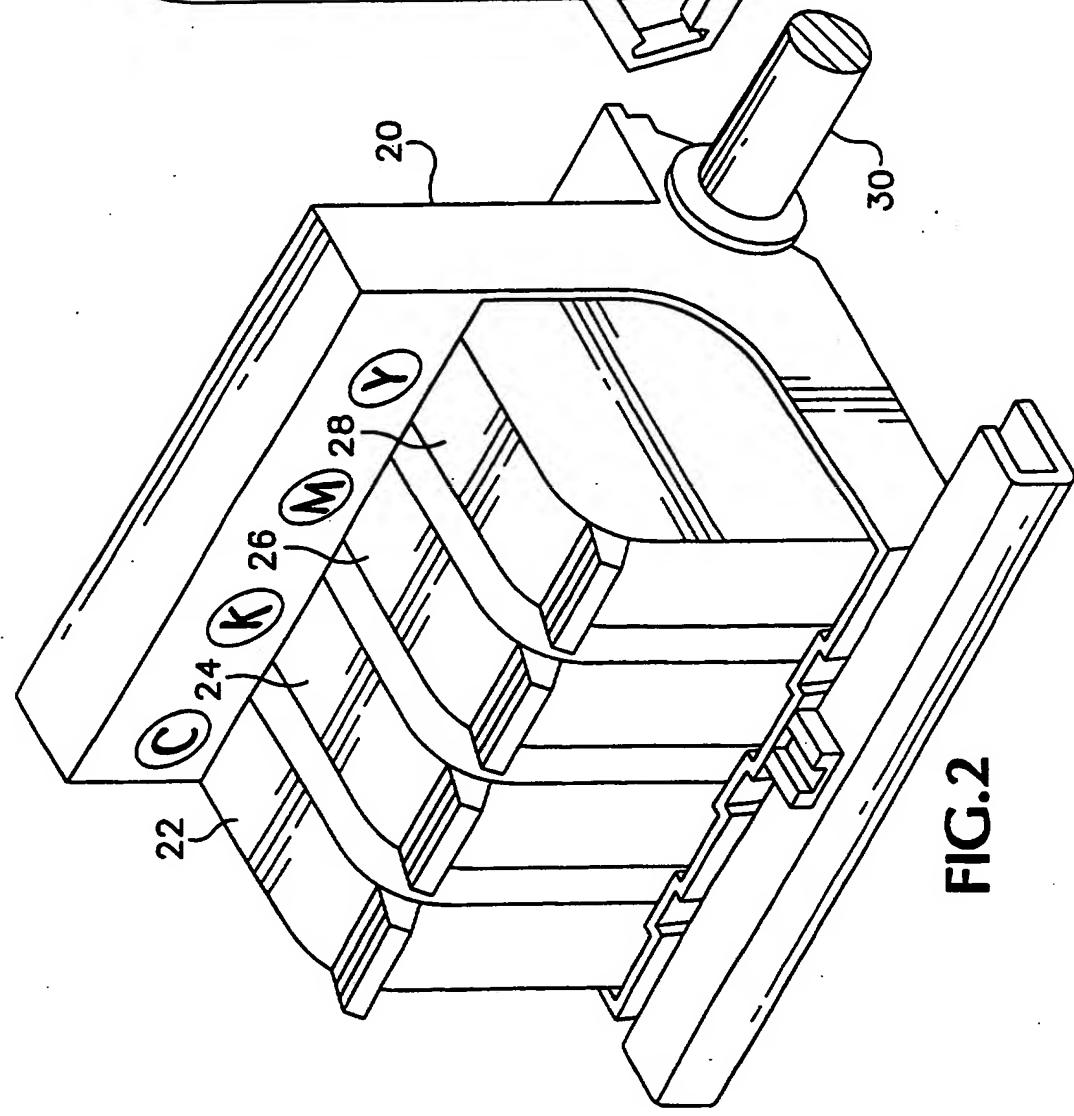
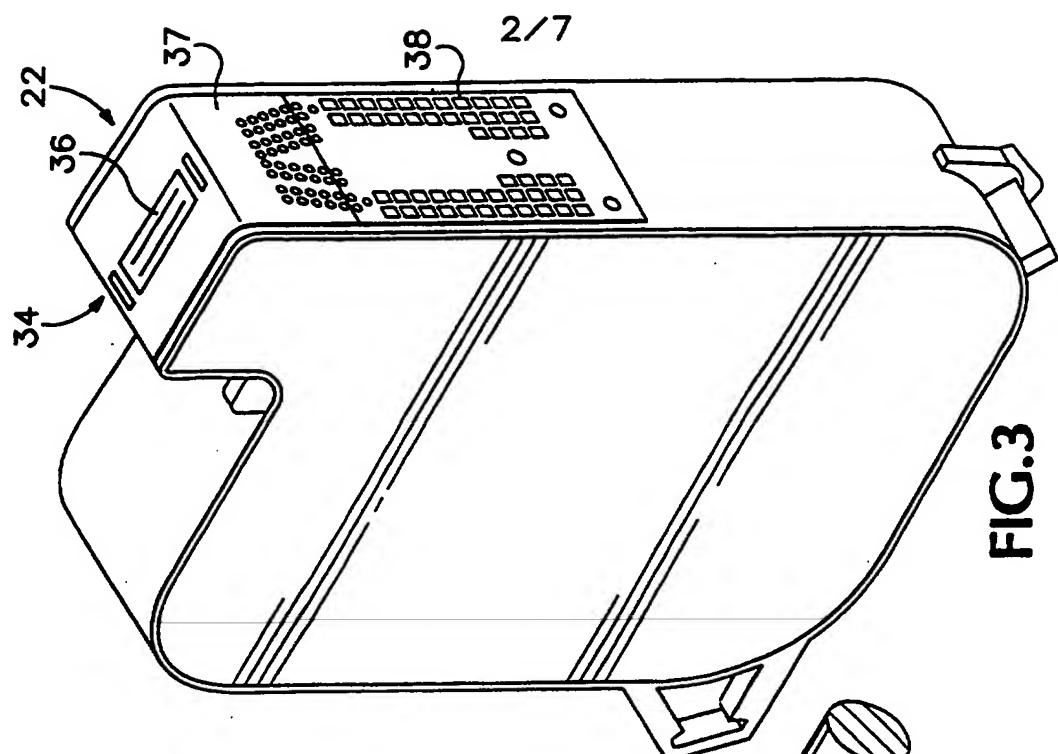


FIG. 1A



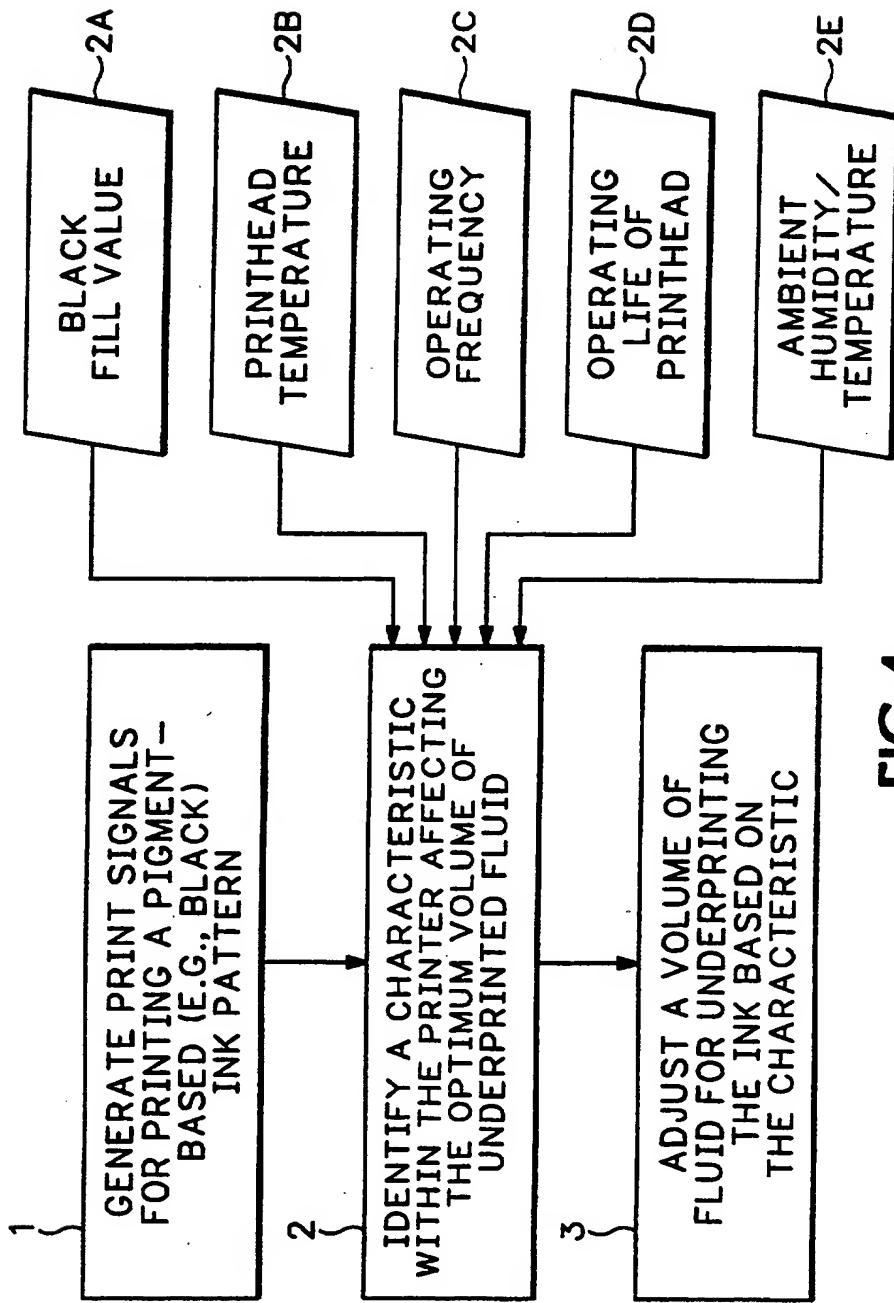
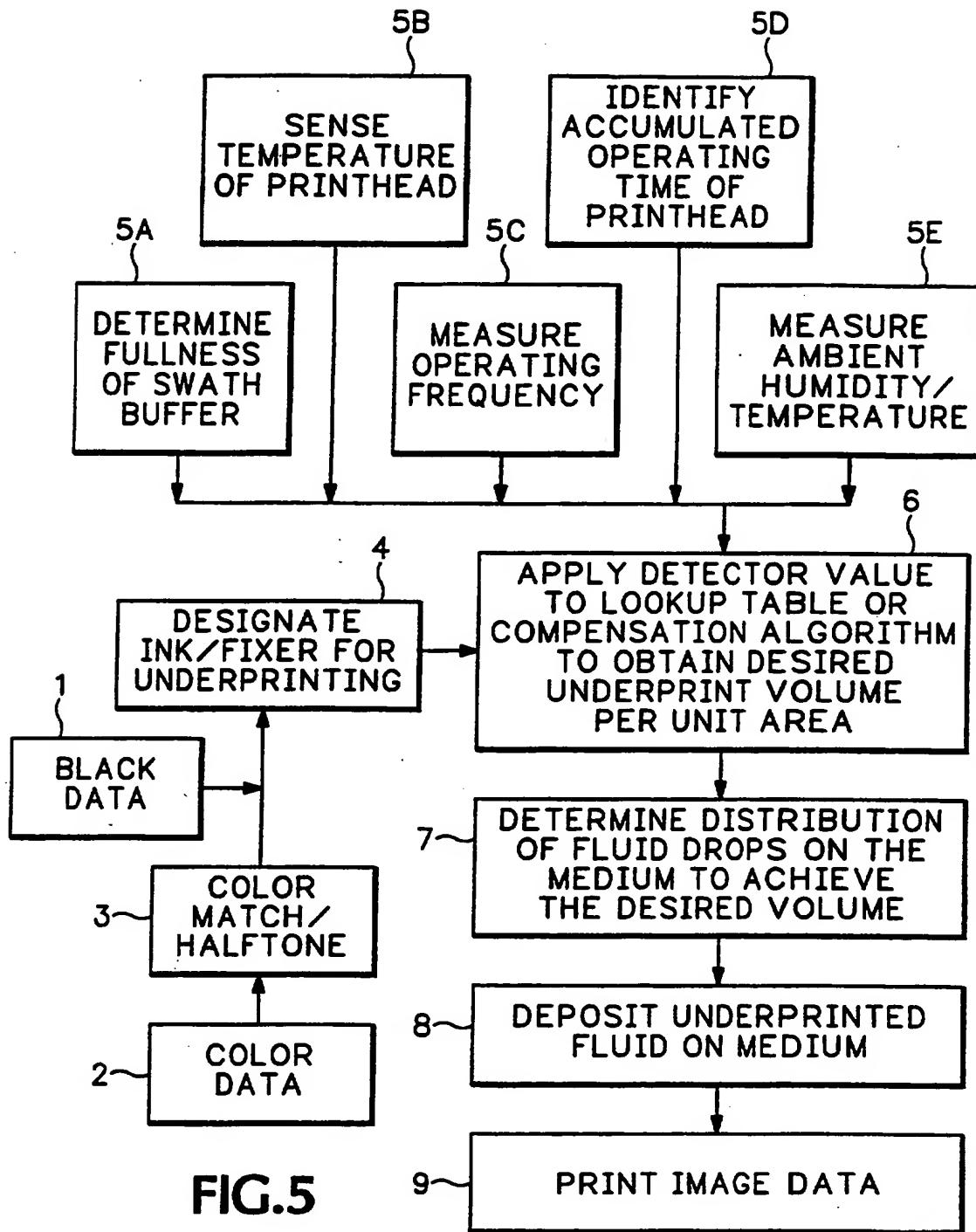


FIG.4



5/7

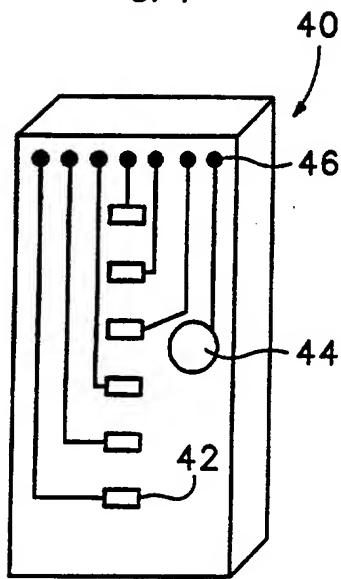


FIG.6

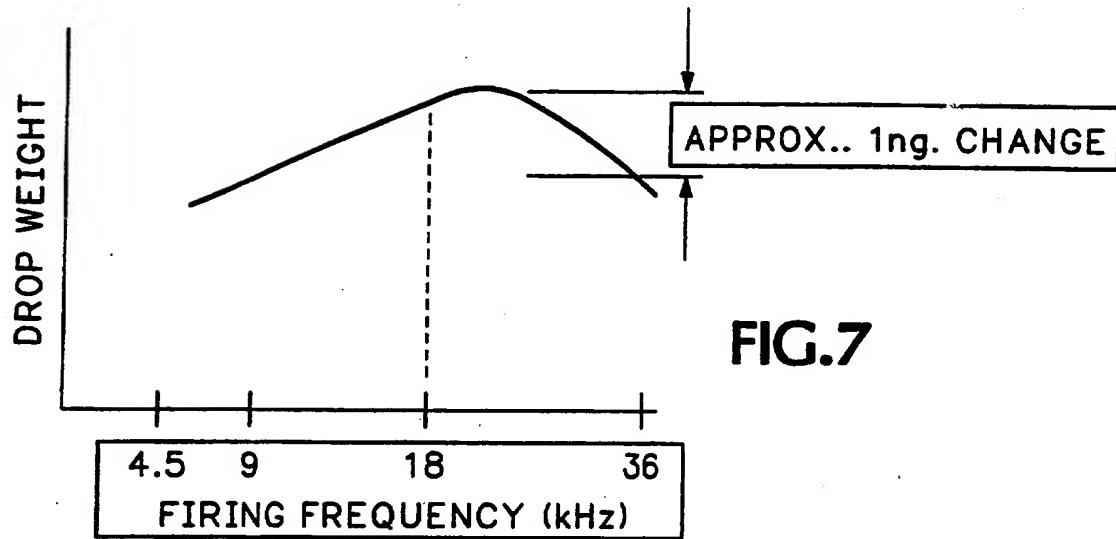


FIG.7

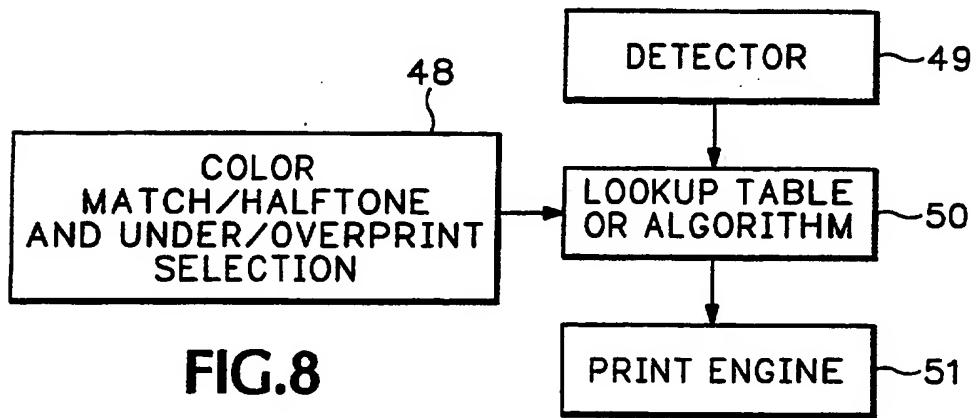
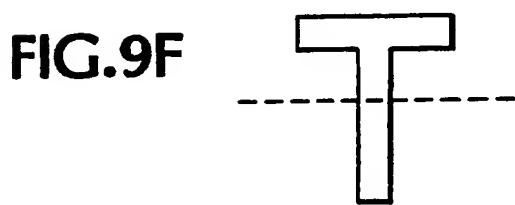
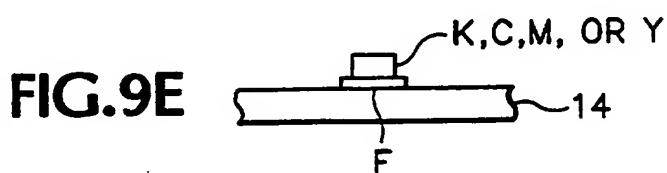
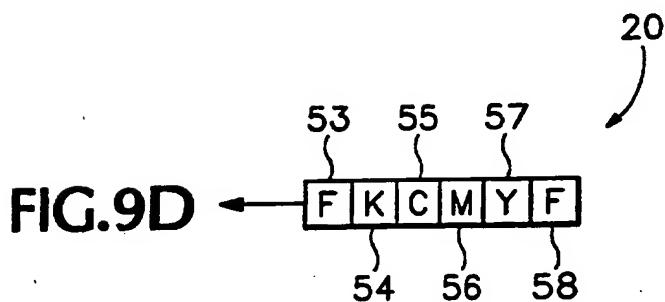
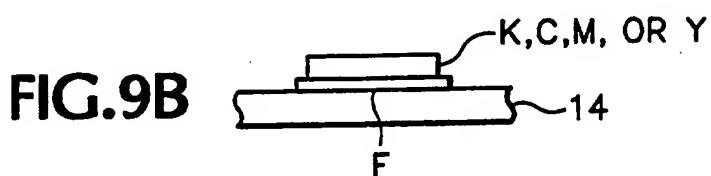
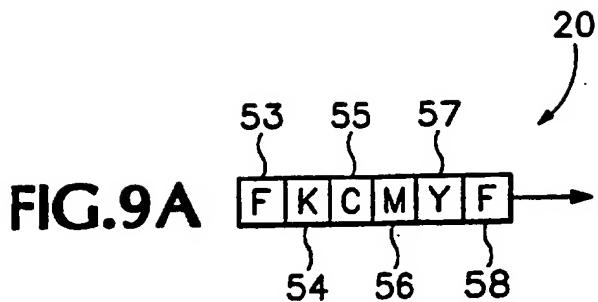


FIG.8



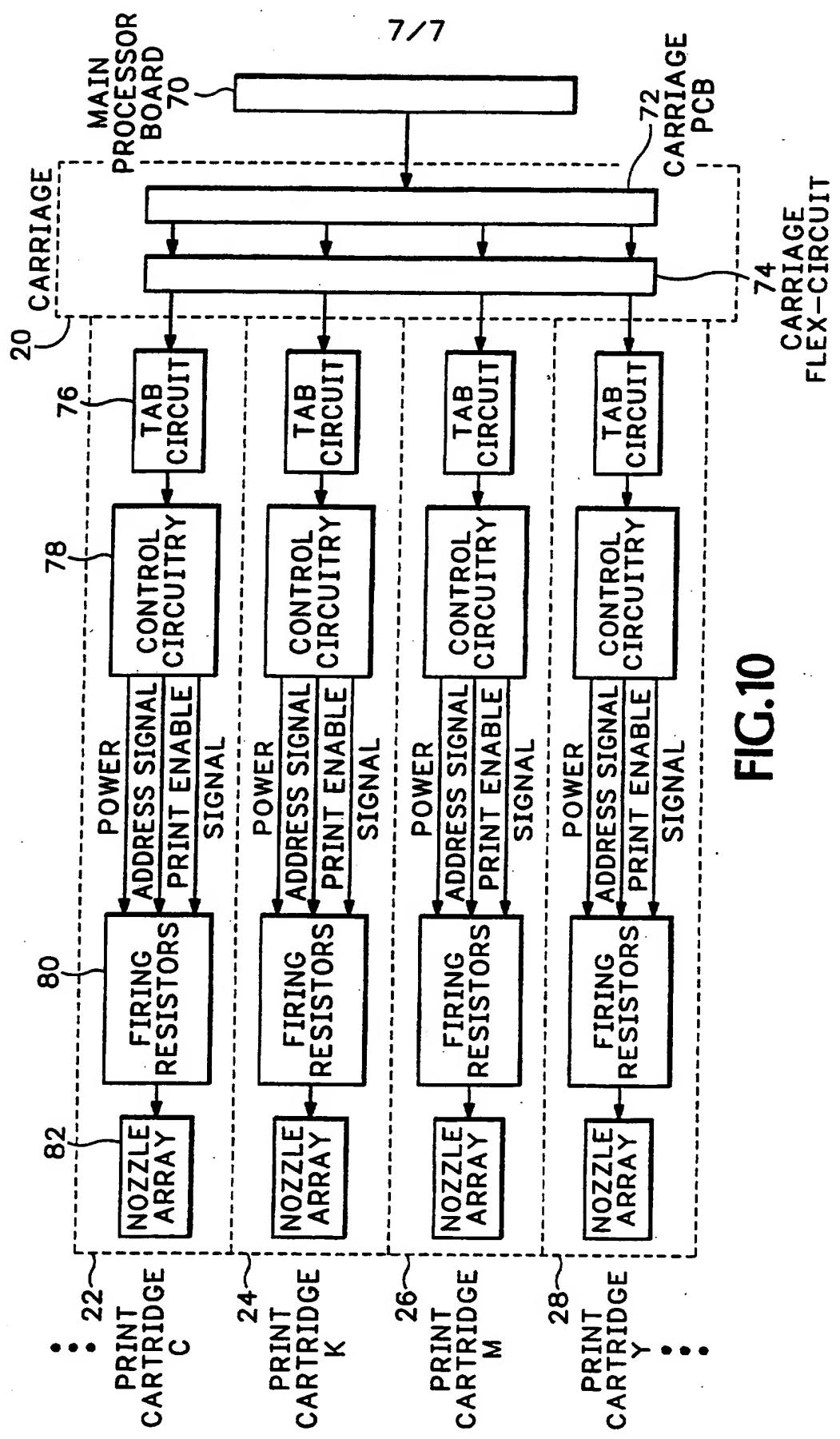


FIG.10

PRINTING TECHNIQUES TO HIDE SWATH BOUNDARY BANDING**BACKGROUND OF THE INVENTION****1. Field of the Invention**

5 This invention relates to inkjet printers and, in particular, to a printing technique for minimizing unequal swath boundary behavior across print regions produced by an inkjet printer.

2. Background

10 This application is related to U.S. Patent Application Serial No. 09/329,974, entitled "DYNAMIC ADJUSTMENT OF UNDER AND OVERPRINTING LEVELS IN A PRINTER", filed on June 10, 1999, and assigned to the common assignee. This prior application is incorporated herein by reference. The prior application provides a dynamic adjustment of the fluid volume used for underprinting and/or overprinting pigment-based inks (or other inks) for speeding up the drying time of the pigment-based ink or improving 15 its adherence to a medium. This technique works well, however, the present Applicants have discovered that white space swath boundary banding occurs in printed areas, which contain underprinted black ink, especially in printing a black object whose height is greater than the printer's swath height

20 A typical high quality color inkjet printer prints using at least four colors of ink: cyan, magenta, yellow, and black. A common black ink is a pigment-based ink where undissolved particles are suspended in a clear vehicle. Such pigment-based ink creates the darkest black with a minimum of bleed into the paper. Since the paper is typically white, any significant bleeding of the black ink into the paper will noticeably reduce the sharpness 25 of the edges of black text or other black graphics.

For non-black color inks, dye-based inks are very popular. Dye-based inks do not have color particles suspended in solution and thus tend to bleed into the paper more than pigment-based inks. Since the dye-based ink wicks or bleeds into the paper, the dye-based inks dry faster than the pigment-based inks, which effectively pool on the paper surface.

30 Non-black color inks may also be pigment-based.

Examples of such inks are described in U.S. Patent Nos. 5,695,820 and 5,626,655 assigned to the present assignee and incorporated herein by reference.

The prior application provides dynamic adjustment of the fluid volume used for underprinting and/or overprinting pigment-based inks (or other inks) for speeding up the drying time of the pigment-based ink or improving its adherence to a medium. The invention identifies a characteristic in the printer that affects the optimum volume of under/overprinted fluid to be printed, such as pen temperature, pen operating frequency, pen operating life, ambient temperature, and ambient humidity, and varies the under/overprinted fluid accordingly.

However solid black with underprinted cyan and magenta can have white space swath boundary banding. In printing systems using underprinting, solid black, cyan and magenta fills are band-free, however the combination of these three colors in an underprinted black area exhibits swath boundary banding. One reason for the banding is that black pigments migrate away from swath boundaries of under printed black ink. Figure 1A shows an example of white space swath boundary banding at underprinted black ink. Cyan and magenta are underprinted under solid black ink. The white space boundary occurs if the printed object is bigger than the print head height (in this illustration, the height is $\frac{1}{2}$ "). The white space boundary in Figure 1A is between Swath 1 and Swath 2 for an object that is solid black and greater than $\frac{1}{2}$ ".

Therefore, what is needed is a technique that can reduce white space swath boundary banding while providing an optimum amount of underprinting fluid as characteristics within the printer change.

SUMMARY

The present invention provides a system to underprint a black object whose height is greater than one swath height of an inkjet printer. In the following examples, it will be assumed that the black ink is pigment-based, and it is desired to underprint the black ink with either a dye-based color ink or a fixer.

A method and apparatus in an inkjet printer for printing a black object whose height is greater than the swath height of the inkjet printer is provided. The printer includes one or more printheads that moves relative to a medium while the printheads are printing on the medium. The printheads include a first set of nozzles for printing dots of a first ink, and a second set of nozzles for printing dots of a second fluid. The process adjusts the volume of the first ink, wherein the first ink is black ink, which is printed over the second fluid. The

black ink volume is greater than the volume of the second fluid. The volume of black ink is increased by using a greater number of nozzles in the first set compared to the number of nozzles used in the second set.

One of the advantages of the present invention is that white space boundary banding is diminished by increasing the number of nozzles for printing a black object whose height is greater than one swath height.

This brief summary has been provided so that the nature of the invention may be understood quickly. A more complete understanding of the invention can be obtained by reference to the following detailed description of the preferred embodiments thereof in connection with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention may be better understood, and its numerous objects, features, and advantages made apparent to those skilled in the art by referencing the accompanying drawings.

Fig. 1A illustrates white space swath boundary banding that occurs in printing an underprinted black object whose height is greater than one swath.

Fig. 1 B illustrates one of many examples of an inkjet printer that incorporates the present invention.

Fig. 2 illustrates the scanning carriage in the printer of Fig. 1B and one possible order of print cartridges in the carriage.

Fig. 3 is a perspective view of one of the print cartridges.

Fig. 4 is a flowchart illustrating the basic steps used in one embodiment of the invention.

Fig. 5 is a flowchart illustrating in greater detail the steps of dynamically adjusting the volume of the under/overprinted fluid.

Fig. 6 is a perspective view of a portion of a printhead illustrating a temperature sensor on the printhead.

Fig. 7 illustrates the effect of firing frequency on ink drop weight.

Fig. 8 illustrates one embodiment of the hardware used to carry out the process of Fig. 5.

Figs. 9A through 9F illustrate the printing of a text character using bi-directional scanning and fixer pens.

Fig. 10 illustrates the electronics within the printer for generating the energization signals for the fluid ejection elements in the printheads.

5 The use of the same reference symbols in different drawings indicates similar or identical items.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1B illustrates one embodiment of an inkjet printer 10 that carries out the invention. Numerous other designs of inkjet printers may also be used while carrying out 10 this invention. More detail of an inkjet printer is found in U.S. Patent No. 5,852,459, to Norman Pawlowski et al., incorporated herein by reference.

Inkjet printer 10 includes an input tray 12 containing sheets of paper 14 which are forwarded through a print zone 15, using rollers 17, for being printed upon. The paper 14 is then forwarded to an output tray 16. A moveable carriage 20 holds print cartridges 22, 24, 15 26, and 28, which respectively print cyan (C), black (K), magenta (M), and yellow (Y). In another embodiment, a fixer print cartridge is located at both ends of the carriage so a fixer can be underprinted or overprinted in both directions. In such an embodiment, all the inks are generally pigment-based or pigment/dye hybrids but can be dye-based.

20 In one embodiment, inks or fixers in replaceable ink cartridges 27 are supplied to their associated print cartridges via flexible ink tubes 29. The print cartridges may also be the type that hold a substantial supply of fluid and may be refillable or non-refillable. In another embodiment, the ink/fixer supplies are separate from the printhead portions and are removably mounted on the printheads in the carriage.

25 The carriage 20 is moved along a scan axis by a conventional belt and pulley system and slides along a slide rod 30. In another embodiment, the carriage is stationery, and an array of stationary print cartridges print on a moving sheet of paper.

30 Printing signals from a conventional external computer (e.g., a PC) are processed by printer 10 to generate a bitmap of the dots to be printed. The bitmap is then converted into firing signals for the printheads. The position of the carriage 20 as it traverses back and forth along the scan axis while printing is determined from an optical encoder strip 32, detected by a photoelectric element on carriage 20, to cause the various ink ejection

elements on each print cartridge to be selectively fired at the appropriate time during a carriage scan.

Fig. 2 illustrates one example of carriage 20 with print cartridges 22, 24, 26, and 28 installed in the order of CKMY, as viewed from the front of printer 10. Other orders and 5 colors may also be used.

Fig. 3 is a perspective view of a print cartridge, which may serve as any of the print cartridges in carriage 20, such as print cartridge 22. Print cartridge 22 contains a reservoir of ink, or has an ink passage connected to an off-axis ink supply, which is connected to a printhead portion 34. The printhead portion 34 basically consists of a printhead substrate 10 containing ink channels leading to chambers surrounding ink ejection elements. A nozzle plate 36 is positioned over the substrate with each nozzle overlying an ink ejection chamber. In one embodiment, nozzles are formed in a flexible tape (a TAB circuit 37). Contact pads 38 contact electrodes in carriage 20 and supply electrical signals to the printhead substrate via traces on the TAB circuit 37. In another embodiment, nozzle plate 36 is an epoxy or 15 metal.

The printhead may use resistive, piezoelectric, or other types of ink ejection elements. Generally, X number of nozzles are used to underprint color, for example cyan and magenta under solid black. In one aspect of the present invention, X number of nozzles are used to underprint color swaths and Y number of nozzles are used to print solid black, 20 where Y is greater than X. The extra number of nozzles provide the extra swath height for underprinted black regions to compensate for the apparent migration of black pigment away from swath boundaries.

As the print cartridges in carriage 20 in Fig. 2 scan across a sheet of paper, the swaths printed by the print cartridges overlap. After one or more scans, the sheet of paper 25 14 is shifted in a direction towards the output tray 16 (Fig. 1), and the carriage 20 resumes scanning. It is important that the same color swaths printed during each scan not significantly vary in hue, otherwise noticeable banding results.

Typically, the drying time for black ink (or other pigment based inks) is typically longer than the drying time for the non-black color inks, if dye-based, due to the different 30 types of inks used. Black ink is preferably pigment-based (although it may be dye-based) while primary color inks are dye-based, pigment-based, or pigment/dye-based. Since the black ink is specifically engineered not to bleed into the paper, the black ink typically has a

longer drying time than the color inks. Thus, the black ink drying time frequently becomes the bottleneck for the drying time of a sheet of paper. The pigment-based ink drying time may be reduced, and adherence to the paper improved, by using clear underprinted fixers. Described below are various techniques for adjusting the volume of the ink or fixer to 5 underprint a pigment-based ink or any other ink that uses underprinting. Fig. 4 is a flowchart of the basic technique used in the invention.

In Step 1, print signals are generated for printing a first ink pattern for which underprinting is desirable. This first ink may, as an example, be a black or other color 10 pigment-based ink, and the underprinted ink may be either a dye-based ink or a fixer.

In Step 2, a characteristic within the printer that affects the optimum volume of the underprinted ink/fixer is determined. Such characteristics may be obtained from: an algorithm for detecting high density fills or high ink fluxes (Step 2A); a thermal sensor embedded in a printhead substrate (Step 2B); a signal identifying the operating frequency of the printhead (Step 2C); a signal indicating the operating life of the printhead (Step 2D); or 15 an ambient temperature/humidity sensor for indicating the characteristics of the media (Step 2E). Any one or any combination of these characteristics may be used in Step 2.

In Step 3, the characteristics identified in Step 2 are used to adjust the volume of fluid (either an underprinted color ink or a fixer) for underprinting the first ink. In one embodiment, adjusting the volume of the fluid in Step 3 is accomplished by depositing more 20 or less ink drops of the fluid. In another embodiment, the pulsed widths of the pulses applied to the ink ejection elements, such as resistors or piezoelectric elements, are adjusted to eject more or less ink from an ink chamber. If black ink is to be underprinted for an object that is greater than the printhead height, the number of nozzles is increased compared to the number of nozzles required to print color, to adjust for white space swath boundary.

Fig. 5 is a flowchart showing in more detail the process of Fig. 4 for adjusting the 25 volume of a fluid underprinting a pigment-based ink, such as black ink, or any other ink for which underprinting is desired.

In Steps 1 and 2 of Fig. 5, black and non-black color data are generated for being reproduced by a color printer. In step 1, the process also determines if a particular black 30 object's height is greater than the printer's swath height and hence requires multiple swaths to print the object. If a particular object's height is greater than the swath height, then the black object is printed using Y number of nozzles to avoid the white swath boundary band

phenomena, where Y is greater than the number of nozzles ("X") used to print another color.

In Step 3, the color data is matched to a color reproducible by the printer, and arrangements of ink dots (halftoning) are determined for reproducing the desired color with the specific inks used by the printer.

In Step 4, the underprinting by certain ink(s) or a fixer is determined. In one embodiment, the underprinting of black ink is by a mixture of cyan and magenta inks. If two fixer print cartridges are used, Step 4 identifies the contribution by each of the fixer cartridges. In one embodiment, Step 4 identifies a nominal volume of the underprinting ink, and a later step varies this nominal volume based on the printer characteristics.

Steps 5A – 5E generate signals from detectors for indicating certain characteristics of the printer. Step 5A of Fig. 5 uses a raster-based algorithm to determine beforehand the amount of black ink to be deposited in one or more swaths. In one embodiment the amount of black ink will depend upon whether a black object whose height is greater than one swath height requires underprinting. If an object whose height is greater than one swath height is underprinted, for example, with cyan and magenta, then the number of nozzles are increased compared to the number of nozzles required to print a black object that is underprinted and where the objects height is less than one swath.

The amount (or ink density) of black ink to be deposited determines the temperature of the black printhead. By knowing the temperature of the black printhead, the black ink drop size is also known. One technique for detecting the amount of black ink to be deposited is to determine the fullness of the swath buffer and assign the fullness an index value. One way to determine the fullness of the swath buffer is to detect digital flags generated when fullness threshold values are exceeded in the swath buffer. Generating flags is common in buffered systems. Swath buffers are conventional and discussed in U.S. Patent No. 5,805,174, entitled Display List Architecture Having Two Dimensional Array of Zones, by Padmanabhan Ramchandran, assigned to the present assignee and incorporated herein by reference. A swath buffer may store from one swath to a full page.

In Step 6 of Fig. 5, the value generated in Step 5A, for example, is applied to a lookup table which associates the value to a fluid volume per unit area required for the underprinted ink or fixer. In another embodiment, the fullness value is used by a compensation algorithm to develop the desired fluid volume per unit area for underprinting.

The lookup table or algorithm also takes into account the anticipated increased temperature of the underprinting printhead. In one embodiment, where Step 4 identifies a nominal volume of the underprinting ink, Step 6 provides an adjustment of the nominal volume based on the printer characteristics.

5 In Step 7 of Fig. 5, the determination of firing an ink ejection element to deposit a dot or not deposit a dot in a certain pixel position is made in order to achieve the desired fluid volume per unit area for the underprinting. In one embodiment, the desired volume of fluid is printed by varying the dot density along the scan axis of the printer. Steps 6 and 7 may be combined, in one embodiment, if the table or algorithm in Step 6 directly identifies
10 the number of underprinted dots for each image dot.

In Step 8 of Fig. 5, the printhead for the underprinting fluid is energized to deposit ink or fixer drops in accordance with Step 7. By dynamically selecting this fluid volume, a more optimal underprinted fluid volume is achieved.

15 In Step 9 of Fig. 5, the image ink(s) for reproducing the data in Steps 1 and 2 is printed. This may be followed by an overprinting step to fix the ink or to prevent hue shifts. Steps 5B through 5E of Fig. 5 provide other printer characteristics that are applied to suitable lookup tables or algorithms to adjust the underprinting fluid volume. Steps 5A through 5E may be employed individually or in any combination. Step 5B detects the actual temperature of the black (or other color) printhead using any conventional thermal
20 sensor. A thermal sensor could be incorporated directly into the printhead, such as into the printhead described in U.S. Patent No. 5,648,806, entitled "Stable Substrate Structure for a Wide Swath Nozzle Array in a High Resolution Inkjet Printer," assigned to the present assignee and incorporated herein by reference.

Fig. 6 is a perspective view of a printhead substrate 40, typically formed of silicon, with heater resistors 42 formed on it for use as ink ejection elements. Also formed on substrate 40 is a thermal sensor 44, which can simply be a PN junction whose conductivity is related to the temperature of the substrate 40. Any other thermal sensor may be used.

25 Thermal sensor 44 is connected to one of the various electrodes 46 along the edges of substrate 40 which connect to contact pads on the print cartridge. These contact pads on the print cartridge are then coupled to various circuits in the printer itself for controlling the printhead and for receiving the thermal readings from the sensor 44.

The temperature value is digitized and applied to either a lookup table (Step 6 of Fig. 5) or used in a compensation algorithm to ultimately control the density of underprinted ink drops so that the fluid volume per unit area meets the desired volume, as discussed previously with respect to Steps 6, 7, and 8 in Fig. 5.

Ink drop volume is affected by the ink drop firing rate due to the fluid mechanics of the ink flowing in the printhead. The graph of Fig. 7 illustrates the variation in drop weight versus firing frequency, with the drop weight changing by as much as 25% over the range of firing frequencies.

Step 5C of Fig. 5 detects the firing rate of the black (or other ink to be underprinted) printhead. Such a detector may include one or more counters for counting the pulses applied to the printhead over a period of time. The frequency value is applied to a lookup table or a compensation algorithm to ultimately control the density of fluid drops used to underprint a particular ink, as described with respect to Steps 6-8 in Fig. 5.

The drop weight generally increases over the life of the pen due to wear on the pen. Step 5D of Fig. 5 generates a value corresponding to the accumulated operating time of the pen. This determination may, for example, be based upon the number of drops fired or based upon the total time of use of the pen. Such a value is applied to a lookup table or a compensation algorithm, as previously described, to control the amount of underprinted fluid.

The optimum volume of underprinted fluid is also determined by the characteristics of the medium. These characteristics are affected by the ambient relative humidity and ambient temperature. A conventional humidity detector is located within the printer, and its value is converted to an index for a lookup table or for use by a compensation algorithm, as previously described. The output of the lookup table or algorithm is then used to ultimately control the density of the underprinted ink droplets. Ambient temperature may also be used and the combination of humidity and temperature converted into a value for use by the lookup table or algorithm.

In the low relative humidity range (10% R.H.), the paper moisture content is low. More underprinting of fixer or color ink is required to pre-treat the page before the black or other color ink contacts the paper. With a humidity sensor, levels could be preset based on several humidity ranges using the lookup table or compensation algorithm. In a hot and wet condition, (e.g., 35° C, 80% R.H.), text print quality is compromised by the high moisture

content in the paper, causing poor edge acuity (feathering). By using temperature and humidity measurements, the underprinting level can be decreased or increased to optimize print quality.

The techniques used in Fig. 5 may be used to underprint, overprint, or interleave 5 dots.

Fig. 8 illustrates a circuit that can be used for the various techniques described herein. One or more lookup tables or algorithms 48 perform color matching, halftoning, and the selection of the underprinting fluid. Detector 49 obtains characteristics about the printer affecting underprinting and/or overprinting. Detector 49 generates a digital value 10 which is used as an index for a lookup table or in a compensation algorithm 50, which then generates a value indicating the fluid volume per unit area to be printed. This value may identify the number of underprinted dots to be printed for a particular image dot. The print engine 51 then prints the actual dots on a medium, as described in Figs. 9 and 10.

Figs. 9A-9F illustrate the underprinting of black ink by a fixer in a bi-directional 15 print mode. In Fig. 9A, a scanning carriage 20 incorporating six print cartridges 53-58, with a fixer print cartridge at both ends, is shown scanning from left to right. It is assumed that the letter "T" will be printed in two passes using black ink. If the letter "T" is greater than the printer's swath height, then Y number of nozzles are used to print in black, where Y is greater than the number of nozzles used to print another color or to print in black if "T" 's 20 height is less than one swath height. In the first pass from left to right, the fixer fluid from print cartridge 58 is deposited and, in the same scan, the black ink from print cartridge 54 is deposited over the fixer, as shown in Fig. 9B, illustrating a cross-section of a sheet of paper 14 with the fixer and black ink printed thereon. Any other color can be underprinted by the fixer. Fig. 9C is a front view of the portion of the T printed on paper 14. The volume of the 25 fixer deposited is determined using any of the methods described in Fig. 5.

In the scan from right to left, shown in Fig. 9D, the fixer fluid from print cartridge 53 is first printed on paper 14 followed by ink from the black ink cartridge 54, as shown in Fig. 9E, to complete the letter T in Fig. 9F.

In one embodiment, the black print cartridge 54 prints at a resolution of 600 dots per 30 inch (dpi) along the paper shift axis, and prints at up to 3600 dpi along the scan axis. The fixer and other color print cartridges can print at the same resolution of the black print cartridge or less, such as 300 dpi. In one embodiment, the volume of the underprinted ink

or fixer is about 25% of the volume of the black ink to be deposited. However, the relative volume is to be based on the particular inks and fixers used and, therefore, an optimal amount cannot be specified herein. The volume of the underprinted ink or fixer may range, for example, between 5 to 50% of the black ink volume. The resolution along the scan axis 5 may be varied to achieve the desired volume of under/overprinted fluid for each image dot printed.

Fig. 10 illustrates the basic circuitry in the print cartridges, carriage 20, and printer 10 for generating the firing signals for the heater resistors in the printheads. The main processor board 70 in the printer performs the well known steps of decoding the print 10 signals from the personal computer connected to an input of the printer and creating a bitmap of the dots to be printed in a swath buffer forming part of the main processor board 70. Additional details of one technique for creating the bitmap of the dots are found in U.S. Patent No. 5,805,174, entitled Display List Architecture Having Two Dimensional Array of Zones, by Padmanabhan Ramchandran, assigned to the present assignee and incorporated 15 herein by reference. The data is transferred to the carriage printed circuit board 72, which uses timing signals from the optical encoder strip 32 (Fig. 1) to generate the addressing signals for firing selected heater resistors in a particular printhead. A carriage flex circuit 74 contains electrodes for being contacted by the contact pads on the print cartridge TAB 20 circuit 76. A control circuit 78 on the printhead distributes the signals to the various heater resistor circuits. The heater (or firing) resistors 80 vaporize a portion of the ink in their associated chambers to expel a droplet of ink through an associated nozzle in a nozzle array 82. The carriage may also include fixer cartridges or other color cartridges.

The above description has focused on single pass type printers where the paper is shifted a swath width after a single pass. However, the underprinting can also be used in a 25 multiple pass mode of printing where swaths in two consecutive scans either fully or partially overlap. In such a multipass printer, the black printhead (or set of nozzles) need not have other color printheads (or sets of nozzles) on both sides of it since the overprinting and underprinting can be done in two separate passes.

The present invention is equally applicable to alternative printing systems (not 30 shown) that utilize alternative media and/or printhead moving mechanisms, such as those incorporating grit wheel, roll feed, or drum or vacuum belt technology to support and move the print media relative to the printhead assemblies. With a grit wheel design, a grit wheel

and pinch roller move the media back and forth along one axis while a carriage carrying one or more printhead assemblies scans past the media along an orthogonal axis. With a drum printer design, the media is mounted to a rotating drum that is rotated along one axis while a carriage carrying one or more printhead assemblies scans past the media along an 5 orthogonal axis. In either the drum or grit wheel designs, the scanning is typically not done in a back and forth manner as is the case for the system depicted in Fig. 1.

Multiple printheads may be formed on a single substrate. Further, an array of printheads may extend across the entire width of a page so that no scanning of the printheads is needed; only the paper is shifted perpendicular to the array.

10 Heating of the paper by a heat source may be used in conjunction with the invention for speeding up dry time.

Additional print cartridges in the carriage may include orange, green, red, blue, or reduced dye/pigment level inks such as light cyan, light magenta, or light yellow.

15 While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the appended claims are to encompass within their scope all such changes and modifications as fall within the true spirit and scope of this invention.

CLAIMS

1. A method performed by an inkjet printer, for printing a black object having a height that is greater than a swath height of the inkjet printer, said printer moving one or more printheads relative to a medium while said one or more printheads are printing on said medium, said one or more printheads including a first set of nozzles for printing dots of a first fluid, and a second set of nozzles for printing dots of a second fluid, said second fluid for interacting with said first fluid on said medium; said method comprising:

5 adjusting a volume of the first fluid, wherein the first fluid is black ink and is printed over the second fluid, and the black ink volume is greater than a volume of the second fluid,
10 wherein the volume of black ink is increased by increasing a number of nozzles in the first set of nozzles compared to a number of nozzles in the second set of nozzles.

2. The method of Claim 1, wherein said second fluid is a fixer.

15 3. The method of Claim 1, wherein said second fluid is a dye-based ink.

4. The method of Claim 1, wherein said first fluid is a pigment-based ink.

5. The method of Claim 1, wherein said first fluid is printed over said second fluid.

20 6. The method of Claim 1, wherein said one or more printheads include at least a first printhead for printing cyan ink, a second printhead for printing black ink, a third printhead for printing magenta ink, and a fourth printhead for printing yellow ink.

25 7. An apparatus in an inkjet printer comprising:

one or more printheads including a first set of nozzles for printing a first fluid, and a second set of nozzles for printing a second fluid, said second fluid for interacting with said first fluid on a medium; wherein the first set of nozzles includes a greater number of nozzles than the second set of nozzles for printing a black object having a height that is greater than
30 a swath height of the printer;

a detector for detecting a characteristic within said printer; and

a controller for varying a volume of said first fluid, wherein the first fluid is black ink used for printing the black object.

8. The apparatus of Claim 7, wherein said second fluid is a fixer.

5

9. The apparatus of Claim 7, wherein said second fluid is a dye-based ink.

10. The apparatus of Claim 7, wherein said first fluid is a pigment-based ink.

10

11. The apparatus of Claim 7, wherein said first fluid is printed over said second fluid.

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12. The apparatus of Claim 7, wherein said one or more printheads include at least a first printhead for printing cyan ink, a second printhead for printing black ink, a third printhead for printing magenta ink, and a fourth printhead for printing yellow ink.



Application No: GB 0109934.0
Claims searched: 1-12

Examiner: Gary Williams
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Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK Cl (Ed.S): B6F: FLT
Int Cl (Ed.7): B41J: 2/21,29/393
Other: Online: EPODOC, PAJ, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X,P	GB 2352427 A (HEWLETT-PACKARD) See Figs.4-10, page 8 line 10 - page 15 line 22, esp. page 15 lines 17-22)	1-12
A	EP 0901273 A2 (HEWLETT-PACKARD) See Figs.1&2, abstract, page 2 lines 3-5, page 3 lines 7-19	1
A	EP 0829353 A2 (CANON) See Figs.1-7, page 4 line 43 - page 7 line 14	1
A	EP 0703087 A2 (CANON) See Fig.10, page 10 line 38 - page 11 line 17	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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